Additions to the flora of the Matawan formation

EDWARD W. BERRY

(WITH PLATES 1–5)

The following notes are based for the most part on collections made by the writer near Cliffwood, Monmouth County, New Jersey, during the spring and summer of 1903, although some of the material was collected the previous year.

This locality, in all probability, furnished the specimens described by Newberry in his Flora of the Amboy Clays as from "near Keyport." He did not, however, recognize it as a distinct horizon. Hollick in 1897 published a brief paper on this flora, recognizing twenty-six species from this locality. The writer in previous papers * increased this number to seventy-two and the present contribution raises the number of known species to eighty-five, most of which are represented by well-characterized remains.

A complete discussion of this flora is postponed for the present and will be included in a subsequent paper on the geology of the Matawan formation now in course of preparation.

No attempt has been made to give the synonymy except where the species mentioned is new to the flora.

FILICALES

GLEICHENIA ZIPPEI (Corda) Heer. (PLATE 4, FIGURE 6.)

Pecopteris Zippei Corda in Reuss, Verstein. 95. *pl. 49. f. 1.* 1846. Unger, Kreidef. Ostr. Sitz. Acad. Wien. 8. *pl. 2. f. 1.* 1867. Schimper, Pal. Vég. 1 : 672. 1869.

Gleichenia Zippei Heer, Fl. Foss. Arct. 1 : 79. *pl. 43. f. 4.* 1868 ; 3 : 44, 90, 97. *pl. 4, 5, 6. f. 1–3 ; pl. 7. f. 2 ; pl. 25. f. 1–3 ; pl. 26. f. 10–13.* 1874 ; 4 : 49. *pl. 32. f. 6, 7.* 1877 ; 6^2 : 36. *pl. 3. f. 2.* 1882 ; 7 : 7. 1883. Newb. Fl. Amboy Clays, 37. *pl. 3. f. 5.* 1896. Ward, Ann. Rep. U. S. Geol. Surv. 19^2 : 664. *pl. 162. f. 9.* 1899.

This widespread species is represented in our collections by a single poor specimen, much broken, and showing only the pinnules of one side. Easily distinguished from *Gleichenia Saundersii*

* Berry, Bull. N. Y. Bot. Gard. 3 : 45–103. *pl. 43–57.* 1903. American Naturalist, 37 : 677–684. *f. 8.* 1903.

Berry, from this formation, by the comparatively longer more rounded pinnules with more numerous secondary veins, nearly all of which are forked. The recorded range for this species is from the Neocomian to the Senonian, inclusive, in Europe, and from the Urgonian to the Cenomanian, inclusive, in this country.

GYMNOSPERMAE

GEINITZIA FORMOSA Heer. (PLATE 4, FIGURES 2, 3.)

Poorly characterized cones of this species were recorded by Hollick from this formation in 1897. Collections made during the past summer contain three characteristic twigs of this species. Leaves are upwards of 12 mm. in length, slender, averaging 1.2 mm. in width, much recurved; only spreading to about 5 mm. from the stem on each side.

Differs from the material described by Knowlton * from the Montana formation in the greater length of the leaves, which are also more slender and much more crowded; both have the thickened stem. Our specimens agree admirably with Newberry's figured specimen from the Raritan, which Knowlton (*l. c.*) considers positively identified. *Sequoia Reichenbachi* (Gein.) Heer from the Matawan formation is much more common, with more slender stems and less crowded leaves, which are also shorter and less recurved.

Pinus delicatulus sp. nov. (PLATE 1, FIGURE 12.)

The single specimen shows a large number of linear, pointed, apparently flat and ribbed, not terete or thickened, much broken and macerated leaves; of which none is apparently perfect. Some fragments are 12 mm. long and all are somewhat less than 1 mm. in width, and a midrib is plainly discernible in some of the fragments. While the illustration apparently shows needle-like leaves, they appear in the clay as of thin and delicate texture.

While these remains may appertain to the same species as the seed described by me from this formation, it has seemed best to keep them separate until they are found more nearly associated. There is considerable resemblance shown to Fontaine's *Laricopsis* of the Potomac formation in appearance and in the deciduous nature of their leaves.

* Knowlton, U. S. Geol. Surv. Bull. 163: 28. *pl. 5. f. 1, 2.* 1900.

PROTOPHYLLOCLADUS SUBINTEGRIFOLIUS (Lesq.) Berry.* (PLATE 1, FIGURE 5.)

The Cliffwood specimen has the nervilles fine, .75–1.00 mm. apart, and shows no trace of a midrib, a feature which is scarcely defined in small leaves of this species, and wanting in several of Heer's figures, as well as in Hollick's leaf from Staten Island.

SEQUOIA GRACILLIMA (Lesq.) Newb. (PLATE 2.)

These cones are exceedingly common in the shingle on the beach after severe storms. Last summer's collections contain no less than thirty-nine specimens, many of which are of considerable size.

Following are the lengths of the largest specimens: 7.3 cm., 7.9 cm., 8.1 cm., 8.25 cm., 8.6 cm., 9 cm., 9.5 cm., 10.2 cm.

Plate 2 gives an excellent idea of the appearance and size variations of these cones. *Figure 3* is the least flattened by compression, being nearly round. The scales are hexagonal and in juxtaposition. Most of the specimens, however, are considerably flattened, the scales are somewhat separated, and they do not preserve their hexagonal outline with any degree of regularity. This is well shown in *figure 4*.

SEQUOIA REICHENBACHI (Gein.) Heer. (PLATE 4, FIGURE 8.)

The specimen figured is probably a small cone of this species, although there is considerable resemblance to some of the cones of the widespread *Sequoia Langsdorfii* (Brongn.) Heer, of the upper Cretaceous and Tertiary of both continents, which comparison is heightened by the finding at Cliffwood of a single detached leaf (*no. 506*) not figured or described, which seems referable to that species, but which may perhaps be a leaf of *Cunninghamites elegans* or *Sequoia heterophylla*.

DAMMARA CLIFFWOODENSIS Hollick. (PLATE 1, FIGURE 11.)

The proofs of my Matawan Flora were not revised until after I had collected the specimen here figured, and I removed the interrogation mark which Hollick placed after this species, as it seems more nearly allied to the scales of the existing *Dammara* than any of Heer's species.

*See Berry, Bull. Torrey Club, 30: 440. 1903.

The specimen is an unusually perfect one and shows that the nearly straight lateral margins which become very thin are not usually preserved. There is no indication of the apical point figured by Hollick; on the contrary the apex is evenly rounded. In outline and size it is very similar to the scale from Tottenville, Staten Island, doubtfully referred by Hollick to *Dammara borealis* Heer. In the present collections these scales are not as abundant as in those of the previous season, although they still form a decided element in this flora.

CUNNINGHAMITES ELEGANS (Corda) Endl. (PLATE 3, FIGURES 7, 8, 9, 11.)

Last summer's collections contain numerous unmistakable fragments of this species, one a twig 7.7 cm. long.

CUNNINGHAMITES SQUAMOSUS Heer.

Remains of this species are not so common as in the previous season's collections, but several good specimens were collected including some twigs 8 cm. long. The portions of stems shown on *plate 5, figures 2* and *3*, are of this species or the preceding.

MORICONIA CYCLOTOXON Deb. & Ett.

Sparingly represented in the collections of 1903 by the same large-sized forms as those previously found.

FRENELOPSIS Schenk, Palaeont. 19[1]: 13. 1869

Several species of Cretaceous plants have been referred to this genus, so named from their resemblance to the existing species of *Frenela* of the Australian region. The consensus of opinion seems to be that they are referable to the *Cupresseae*, although Heer is inclined to ally them with *Ephedra* among the *Gnetales*, and Schimper includes them in the *Taxaceae*. In lower Cretaceous times they ranged from the Mediterranean region of Europe to Greenland and North America, and their latest known appearance is in the Senonian of Westphalia. That these somewhat peculiar forms did not become extinct is evidenced by the remains referred to the closely allied, if not identical, genera *Widdringtonia*, *Widdringtonites* (*Frenelites*) and *Callitris* which occur both in Europe and in America, where they are common in the Creta-

ceous Atlantic coastal plain from New Jersey to Greenland. They persist as late as the Miocene, both in Europe (Bohemia, France, Germany and Italy) and in the Arctic region (Kudliset). Schenk (*l. c.*) calls attention to the great resemblance to *Frenelopsis* of the remains from the Italian Tertiary which Massalongo describes under the name of *Aularthrophyton* and of which Fontaine (1889) says: "It is difficult to believe that they belong to different genera."

The living genus is, according to modern usage, included in *Callitris* Vent., which as thus constituted becomes divisible into four sections: (1) *Octoclinis* (*Frenela* Benth.), (2) *Hexaclinis* (*Frenela* Mirb.), (3) *Pachylepis* (Brongn.) = *Widdringtonia* Endl., and (4) *Eucallitris* (Brongn.). The first two sections with some seven species are confined to the Australian region, while section 3 is confined to South Africa and Madagascar, and section 4 with one species, *Callitris quadrivalvis* Vent., is confined to the north coast of Africa. The habitat of the latter leads Coulter (1901) to suggest a recent avenue of migration through the southern Asiatic region, but it should be remembered that northern Africa was geographically and biologically a part of Europe in the upper Eocene, again in the lower Miocene, and finally during the early Pliocene, so that *Callitris quadrivalvis* might well be a relict of the similar species we find in the European Miocene. The South Africa and Madagascar forms may have traversed the ancient land connection between Africa and Asia in order to reach Australia, although their absence in the present Asiatic flora is remarkable if this was the route taken. It is quite possible that their actual migration was over the land bridge formed by the northerly extension of the continent Antarctica, which recent zoo-geographers are making so much use of (Blanford 1890, Forbes 1893, Osborn 1900).

The distribution of the *Cupresseae* as a whole, in past times as well as in the present, while a problem so intricate as to baffle our present knowledge, is one of exceeding interest.

FRENELOPSIS HOHENEGGERI (Ett.) Schenk. (PLATE 4, FIGURES 9, 10.)

? *Culmites priscus* Ett. Beitr. Fl. Wealdenp. 1[3]: 24. *pl. 1. f. 5* 1852.
Thuites Hoheneggeri Ett. *ibid.* 26. *pl. 1. f. 6, 7.* 1852.

Frenelopsis Hoheneggeri Schenk, Palaeont. 19[1]: 13. *pl. 4. f. 5–7; pl. 5. f. 1, 2; pl. 6. f. 1–6; pl. 7. f. 1.* 1869. Heer, Fl. Foss. Arct. 3: 73. *pl. 18. f. 5–8.* 1874; 6[1]: 7. *pl. 2. f. 1–3.* 1880; 6[2]: 16. 1882. Fontaine Proc. U. S. Nat. Mus. 16: 275. *pl. 42. f. 4, 4a.* 1893. Newb. Fl. Amboy Clays, 58. *pl. 12. f. 4, 5.* 1896.

This species which is common in the Urgonian of Austrian Silesia has been quite elaborately described and figured by Schenk (*l. c.*). If the various identifications of other authors are correct it was a widespread and persistent type, ranging from the Neocomian to the Turonian in Moravia, France, and Austrian Silesia, as well as in Greenland (Kome). In the United States it has been recorded from the Trinity of Texas and the Raritan of New Jersey, while very similar species occur in the Potomac of Maryland and Virginia. Its occurrence in the Matawan brings it down to a still later period. The Matawan specimens are numerous and fragmentary, and are distinguished with difficulty from the many fragments of other twigs preserved in the clays, all of which except the silicified forms have shrunk and have a more or less jointed appearance. All are decorticated and I fail to find any traces of leaves, but the regularity of the joints and the absence of longitudinal cracks in the larger specimens, which are always present in other twigs of similar size, has constrained me to refer them to the above species. Until material with positive traces of leaves is found this reference can only be provisional.

Gymnospermous Cone. (PLATE 4, FIGURE 7.)

I cannot conclude whether this is a cone with comparatively thin overlapping pointed scales, or whether it is a much-worn cone with thick-keeled scales which would then be inverted in the figure. The scales certainly seem to overlap in places, but this feature is much obscured, and I rather incline to the interpretation that we have a petrified cone of *Sequoia* which has washed out of the clay and become much reduced and worn smooth in the wash of the beach. As it stands it might be compared, except for its larger size, with the staminate strobili of *Podocarpus* or *Phyllocladus*. If it should prove to be a cone with imbricated pointed scales I would be inclined to associate it with the genus *Cunninghamites*, remains of which are so abundant in this formation. In this connection its resemblance to the cones described by Ettings-

hausen as *Cunninghamites Sternbergii*, from the synchronous horizon of Niederschöna, Saxony, is perhaps more than suggestive.*

ANGIOSPERMAE

MYRICA Linn. Sp. Pl. 1024. 1753

A cosmopolitan genus at the present time, except for the Australian region (Notogaea), although remains referred to this genus have been described by Ettingshausen from the Tertiary of eastern Australia and New Zealand.

The existing species number about three-score and are wide-ranging, the same species thriving within wide limits of climate and soil conditions. As might be expected from its scale of organization, *Myrica* is abundant during the Cretaceous, showing its greatest display of extinct forms in the Tertiary, however. Well represented in the fossil floras of Europe, Schimper thirty years ago records eighty-six species of leaves and one of fruit, mostly from European localities, where they make their greatest display somewhat later in the Tertiary than they do in America. The fossil species found on this continent number some seventy forms, distributed as follows: Potomac 1; Raritan (N. J.) 8; Raritan (Islands) 3; Dakota 10; Atane 5; Patoot 3; Montana 2; Laramie 2; Eocene 11; Green River group 19; Miocene 4; Miocene (so-called) of Greenland 9.

Eighteen of these forms are common to Europe.

Myrica Cliffwoodensis sp. nov. (PLATE 4, FIGURE 1.)

This species is founded on a single drupe or nutlet, which is 4.1 mm. in diameter, and which is almost certainly referable to *Myrica*. Although slightly flattened by pressure, it was evidently globose and had a short stem, somewhat under 2 mm. in length. While it may appertain to *Myrica Heerii* Berry, the only species represented by leaves in this formation, we cannot be certain of this and it was thought best to keep it separate.

Seeds, so called, of *Myrica* are reasonably common as fossils, of which the following have come to my notice:

* Ettings. Kreidef. v. Niederschöna: Sitzb. Akad. Wiss. Wien, 55^1: 12. *pl. 1. f. 4-6.* 1867.

Ludwig, 1858, describes them from the Miocene lignite beds of Wetterau at Dorheim in Hesse, and Engelhardt, 1870, detects the same species (*Myrica granulosa*) in the Tertiary of Saxony, at Quatitz and Kleinsaubernitz.

Heer, 1859, describes fruits of *Myrica Ungeri* from the Miocene of Switzerland.

Heer, 1868, refers fruit and leaves from the Tertiary of North Greenland (Atanekerdluk) to *Myrica acuminata* Unger.

Heer, 1869, describes seeds in the same clays with the leaves of *Myrica Schenkiana* from Quedlinburg (Senonian). The same year Heer describes fruit from Rixhöft which he referred to *Myrica Studeri* and from Rauschen which he referred to *Myrica* (*Comptonia*) *Vindobonensis* both from the Baltic Amber (Oligocene).

Saporta, 1866, discovered the fruit of *Myrica hakeaefolia* in the French Miocene at Armissan.

Lesquereux, 1874, describes stems and seeds from the Dakota group of Nebraska (*Myricae*? semina).

Heer, 1874, describes seeds and leaves from Atanekerdluk, Greenland (Cenomanian) under the name of *Myrica Thulensis*.

Lesquereux, 1878, describes as *Carpites Myricarum*, seeds found with the leaves of *Myrica Torreyi* at Black Buttes, Wyoming (Laramie).

Heer, 1882, describes fruit from Ivnanguit, Greenland (Cenomanian).

Heer, 1883, figures the fruit of *Myrica* (*Comptonia*) *parvula* Heer from the Patoot beds (Senonian) of Greenland.

Velenovsky, 1883, describes and figures catkins and fruit of *Myrica* from the Cenomanian of Bohemia.

POPULITES TENUIFOLIUS Berry.

A single leaf of this species collected on July 29, 1903.

QUERCUS HOLLICKII Berry. (PLATE 3, FIGURES 4, 5.)

The present season's collection contains two specimens of this species in which the margin is less serrate and more inclined to be crenate, characters which are not very well brought out in the plate. They show some resemblance to *Celastrophyllum crenatum* Heer, but have a more ascending base and straighter secondaries.

Quercus eoprinoides sp. nov. (PLATE 4, FIGURE 11.)

Leaf ovate-lanceolate, about 10 cm. long by 3.5 cm. in greatest width; coarsely toothed, the rounded teeth becoming mere undulations toward the base; secondaries straight craspedodrome, leaving the midrib at an angle of about 35°; venation much obscured; leaf-substance apparently thin but coriaceous in texture.

Among the fossil leaves of this genus, ours shows some resemblance to the *forma obtusata* of *Quercus Westfalica* of Hosius & von der Marck (Senonian). In size and outline it may be compared with *Quercus flexuosa* Newb. from the Cretaceous of

Washington (state) and with *Quercus Lyellii* Heer from the Greenland Tertiary, both of which however have camptodrome venation. A leaf-fragment from the Laramie of Yellowstone Park termed by Knowlton *Phyllites* sp.* also seems to be quite similar.

Among the living species of oaks this Matawan species bears considerable resemblance to some of the leaves of the hybrid *Quercus Rudkinii* Britton, which may be found growing within a short distance of where the fossils were obtained. The living species has the venation camptodrome, however. The resemblance to *Quercus prinoides* Willd. in size, outline, and venation is most striking; the only difference being the tendency of the modern leaves to become wider and more decidedly toothed; numerous identical leaves may be found, however. *Quercus prinoides* has a wide range throughout the United States, mostly east of the Mississippi river, and may be phylogenetically related to the Matawan leaf.

FICUS ATAVINA Heer. (PLATE 1, FIGURES 8, 9; PLATE 3, FIGURE 6.)

Ficus protogaea Heer (non Ettingshausen, 1867), Fl.. Foss. Arct. 3: 108. *pl. 29. f. 2b; pl. 30. f. 1–8.* 1874. Hollick, Bull. Torrey Club, 21: 51. *pl. 175. f. 4.* 1894.

Ficus atavina Heer, Fl. Foss. Arct. 6^2: 69. *pl. 11. f. 5b, 7b, 8b; pl. 17. f. 8b; pl. 19. f. 1b; pl. 20. f. 1, 2.* 1882. 7: 26. 1883.

Remains of several leaves of this species have been found at Cliffwood recalling the handsome leaves of the commonly cultivated *Ficus elastica* Roxb. with which Heer originally compared it along with *Ficus Benjaminea* and *F. stricta.* There is considerable resemblance to *Ficus Krausiana* Heer, which is recorded from the Dakota group of Kansas, the Raritan of New Jersey and Marthas Vineyard, as well as from the Cenomanian at Moletein, Moravia. The latter species is however more ovate. Our leaf is almost the counterpart in size, outline and venation of *Ficus Peruni* Velen. from the Cenomanian of Bohemia. The venation of his *figure 2* is identical with the Matawan leaf figured at *6* on our *plate 3.* Velenovsky compares *F. Peruni* with the living *Ficus nitida* Thunb. and *F. cuspidata* and *F. pulchella* Schott. He compares it with the fossil *F. Krausiana* Heer, and with the species we are considering.

* U. S. Geol. Surv. Monogr. 32^2: *pl. 78 f. 7.* 1899.

MAGNOLIA SPECIOSA Heer. (PLATE 3, FIGURE 10.)

Magnolia speciosa Heer, Neue Denksch. Schw. Gesells. **23**: 20. *pl. 6. f. 1; pl. 9. f. 1; pl. 10. f. 1.* 1869. Lesq. Cret. & Tert. Fl. 72. 1874. Fl. Dak. Group, 202. *pl. 60. f. 3, 4.* 1892. Hollick, Trans. N. Y. Acad. Sci. **12**: 234. *pl. 7. f. 4.* 1893. Bull. Torrey Club. **21**: 60. *pl. 178. f. 5.* 1894. Bull. Geol. Soc. Am. **7**: 13. 1895. Knowlton in Hill, Ann. Rep. U. S. Geol. Surv. 21^2: 318. 1901.

Described originally from the Cenomanian of Moravia (Moletein), it has been identified at various localities in the Dakota Group, Tuscaloosa, and Island Raritan. It has not as yet been detected in the Cenomanian of Greenland, although some of Heer's figures of *Magnolia Capellinii* are suggestively similar; the latter species is, as a rule a wider, more robust leaf.

Magnolia speciosa seems related to a group of leaves exemplified by *Magnolia pseudoacuminata* Lesq., of the Dakota; *M. tenuinervis* Lesq., as identified by Knowlton from the Montana formation; *M. amplifolia* Heer, from Moletein and the Dakota, and *M. Californica* Lesq., from the Tertiary.

MAGNOLIA CAPELLINII Heer. (PLATE 3, FIGURE 3.)

Magnolia Capellinii Heer, Phyll. Crét. Nebr. **21**. *pl. 3. f. 5, 6.* 1866. Fl. Foss. Arct. **3**: 115. *pl. 33, f. 1–4.* 1874; 6^2: 90. *pl. 24. f. 3–5; pl. 25. f. 1–3; pl. 45. f. 1.* 1882. Lesq. Rept. on Clays, N. J. 29. 1878. Fl. Dak. Group, 203. *pl. 66. f. 1.* 1892. Velenovsky, Fl. Boehm. Kreidef. **3**: 20. 1884. Hollick, Trans. N. Y. Acad. Sci. **12**: 234. *pl. 6. f. 6.* 1893. Bull. Geol. Soc. Am. **7**: 13. 1895. Dawson, Trans. Roy. Soc. Canada, 11^4: 63. *pl. 11. f. 49; pl. 13. f. 49a.* 1894.

Lesquereux in 1878 identified this species from the perishable material collected by Professor Cook at Sayreville, N. J., but it has not since been reported from the Raritan. None of Newberry's Amboy Clay material was of this species, although he made particular search for it. It should be remembered, however, that the majority of his specimens were from other horizons in the Raritan than the one at Sayreville. This is a characteristic Cenomanian species occurring not only in the Dakota, but in beds of this age in Greenland and in Bohemia.

MAGNOLIA TENUIFOLIA Lesq. (PLATE 1, FIGURE 7.)

A well-defined fragment of a large-leaved *Magnolia* with slender veins, referred to the above species because of other remains of this species found here.

LIRIODENDROPSIS Newb. Fl. Amboy Clays, 82. 1896

Comparatively small simple emarginate leaves of the mid-cretaceous, which are ancestral to the more typical species of *Liriodendron.* In view of the wide limits of variation exhibited by the living descendant of these early forms, I am inclined to question the wisdom of generic separation, particularly as the lines of demarcation between the species of the *simplex-primaevum* group have not been, nor can they be, closely drawn.

Saporta has described remains from the Cenomanian of Padrão Portugal, under the name of *Chondrophyton laceratum* * which Ward renames † *Liriodendropsis lacerata* and which he considers very close if not identical with the leaves of this type from the Raritan. I cannot concur in this reference. The remains in question are very vague. Saporta figures two possible interpretations, which are quite dissimilar both in venation and in the character of the apex; and the veins, both secondary and tertiary are depicted as running directly to the margin. The parallelism between the Cretaceous flora of Portugal and that of the United States is close and there is no reason why this type of plant may not have evolved independently in both regions, although in my opinion the remains do not, as yet, corroborate this supposition.

LIRIODENDROPSIS ANGUSTIFOLIA Newb. (PLATE 4, FIGURE 4.)

Liriodendropsis angustifolia Newb. Bull. Torrey Club, 14: 6 (in part). *pl. 62. f. 4.* 1887. Fl. Amboy Clays, 84. *pl. 53. f. 8.* 1896. Hollick, Trans. N. Y. Acad. Sci. 12: 235 (in part). *pl. 5. f. 3b; pl. 7. f. 3.* 1893. Bull. Geol. Soc. Am. 7: 13. 1895.

While the absence of the apex makes this reference provisional in view of minor differences in form and venation, I am inclined to so refer it. It is a species we would naturally expect to find in this formation because of its abundance in the Raritan both in New Jersey and the Islands.

LAURUS PLUTONIA Heer. (PLATE 3, FIGURE 1.)

A thick lauraceous leaf common at Cliffwood.

LAURUS HOLLICKII Berry. (PLATE 3, FIGURE 2.)

This species appears to be fairly common at Cliffwood.

* Saporta, Fl. Foss. Port. 219. *pl. 38. f. 4, 5.* 1894.

† Ward, Rep. U. S. Geol. Surv. 16: 540. 1896.

LAURUS PROTEAEFOLIA Lesq. (PLATE 1, FIGURE 10.)

The leaf figured is of lauraceous texture and denotes a somewhat more slender leaf than Lesquereux's type specimens. The specimen figured was accidentally destroyed.

SASSAFRAS PROGENITOR Newb. (PLATE 1, FIGURE 3.)

Sassafras progenitor Newb.; Hollick, Bull. Torrey Club, 21: 53. *pl. 174. f. 1.* 1894. Bull. Geol. Soc. Am. 7: 13. 1895. Newb. Fl. Amboy Clays, 88. *pl. 27. f. 1–3.* 1896. Berry, Bot. Gaz. 34: 442. 1902.

While it may seem unwise to illustrate and include such an incomplete fragment, the exploitation of such imperfect specimens may often be of more importance in the study of ancient floras than that of more perfect and precisely definable remains. The specimen figured, which was the only one found, shows a part of the central and lateral lobes of a leaf that agrees fairly well with this species (compare with Newberry's *fig. 2*). This is probably a true species of *Sassafras*.

SAPINDUS MORRISONI Lesq.

The present season's collections contain larger leaves of this species than those found in this formation in 1902.

CELASTROPHYLLUM NEWBERRYANUM Hollick.

Hollick obtained this species at Cliffwood a number of years ago. It was not contained in my 1902 collections, but a single specimen was collected on July 29, 1903.

EUCALYPTUS GEINITZI Heer. (PLATE 4, FIGURE 5.)

The specimen figured from my 1903 collections is more decisive than the one previously found at this locality, and shows considerable details of venation. It is a fragment 6.8 cm. long of a linear, somewhat falcate leaf nearly 2 cm. in width, with numerous secondaries which leave the midrib at a wide angle and run without curving nearly to the margin, along which they loop in flat arches. This species resembles somewhat the leaf referred by Saporta and Marion and by Hollick to *Aralia transversinervia*, which leaf is almost certainly not an *Aralia*. It also resembles a single lobe of what I have called *Sterculia Cliffwoodensis* from this formation.

ARALIA RAVNIANA Heer.

The present season's collections contain a single, somewhat indefinite specimen of this species.

ARALIA PALMATA Newb. (PLATE 4, FIGURE 12.)

This was apparently a common species in Matawan times, if we may judge from the abundance of leaf fragments in the clays. The present season's collections contain numerous fragments of this leaf. The one figured I refer doubtfully to this species. It is certainly the same as *no. 6* of last year's collection, but both differ from the typical leaves in their straight secondaries.

ANDROMEDA PARLATORII Heer. (PLATE 1, FIGURES 1, 2.)

Well-characterized remains of doubtful botanical affinity common throughout the Cenomanian of the United States and Greenland. They are particularly abundant in the Raritan formation and the Matawan leaves here figured are the counterpart of several figured by Newberry. They are larger than the leaves from the Dakota group or from Greenland, and are also larger than the Matawan leaves of this species collected in 1902. The secondaries are less numerous and more regularly arched than in Newberry's Raritan leaves.

VIBURNUM Linn. Sp. Pl. 267. 1753

The American fossil forms which are referred to this genus number some forty-seven species, exclusive of seven varieties described by Lesquereux; two of these species occur in Spitzbergen and one on the Island of Sachalin. They have the following distribution: Raritan 1, which is obviously not a *Viburnum;* Dakota 6, plus 7 varieties; Patoot 3; Montana 4; Laramie 7; Denver 4; Eocene 2; Fort Union 17; Miocene of U. S. 2; of Greenland 3; Tertiary of Tongue River (Yellowstone Park) 3. Their distribution marks North America as the original home of the genus; they reached Alaska in the Eocene and crossing the emerged belt where Behring Straits now stand, are found in the Eocene or Oligocene of Sachalin Island. Toward the north and east we find them in Greenland in the Senonian (Patoot) and in Spitzbergen in Heer's "Miocene," which is Eocene or Oligocene.

Three species occur here, two of which are common to Greenland. On the continent of Europe we have one species in the Vraconnian, one in the Senonian, and the balance, which are few in number, Tertiary or recent.

The early appearance of *Viburnum*, one of the *Sympetalae*, associated with *Aralia*, both epigynous forms, suggests to Coulter* a connection of the *Umbellales* with the *Sympetalae* not admitted in current schemes of taxonomy.

Some have been led to doubt the authenticity of the reference of the Cretaceous forms to this genus. It may be noted, however, that most of them have leaves with well-marked characters, which are emphasized by undoubted remains of fruit in a number of instances. The majority of the *Sympetalae* are herbaceous and unsuited for fossilization, while *Viburnum* is shrubby and inhabits swamps and the banks of streams, thereby offering excellent opportunities for preservation. That it is a type of long standing is evidenced by the number of existing species, by the abundance of individuals, and their wide range. They number upwards of one hundred, of subtropical and temperate eastern Asia and North America; Europe has but three species, two of which occur in northern Africa. A probably distinct phylum (*Oreinotinus* Örsted) of about thirty species inhabits Central and South America along the Andes, two of the species being common to Jamaica.

Viburnum Mattewanense sp. nov. (PLATE 4, FIGURE 13.)

A single imperfect specimen of a leaf clearly referable to this genus, and differing from *Viburnum Hollickii* Berry from this formation in its more broadly oval outline and more decided marginal teeth; the ascending basal secondaries are wanting and the first pair leave the midrib at an angle more than twice as great as in *V. Hollickii*.

Leaf 7 cm. wide and between 10 and 11 cm. in length; substance thin; secondaries slender and curved, more remote than in the existing species; lower outside branches of the first secondary have their tips united by a thin vein parallel with the secondary, indicating that the basal portion of the margin was entire; distad the tertiaries curve directly to the marginal teeth; balance of the tertiaries percurrent at right angles to the secondaries.

* Coulter, Morphology of the Angiosperms, 1903.

INCERTAE SEDIS

TRICALYCITES PAPYRACEUS Newb. (PLATE 1, FIGURE 4.)

Tricalycites papyraceus Newb.; Hollick, Bull. Torrey Club, 21: 63. *pl. 180. f. 1 (?), 8.* 1894.

A well defined organism of unknown affinity, dicotyledonous according to Hollick. Consists usually of a small nucleus with three membranous wings and is very common in the Raritan of New Jersey, occurring also on Staten and Long Islands, Chappaquidick and Block Islands, also occurring in the Tuscaloosa formation of Alabama. From the Matawan I have obtained but a single specimen of but one wing. *Tricalycites* is probably comparable with the bracts so largely developed in some of the *Juglandaceae* and *Betulaceae.*

CARPOLITHUS JUGLANDIFORMIS Berry.

Carpolithus juglandiformis Berry, Bull. N. Y. Bot. Gard. 3: 100. *pl. 46. f. 8.* 1903.

Carpolithus dubius Berry, Bull. N. Y. Bot. Gard. 3: 100. *pl. 48. f. 7.* 1903.

The remains named by me *Carpolithus juglandiformis* in drying and shrinking away from the matrix leave an impression exactly similar to that of *Carpolithus dubius*, showing that both appertain to the same plant and are the remains of nut-like fruit with a striated husk, the botanical affinity of which I have not been able to conjecture. They show considerable resemblance in a general way to what Newberry* calls *Tricarpellites striatus*, and which occur abundantly in the Raritan formation at Woodbridge, N. J. The Matawan remains fail to show any pointed apex and have not been found associated in threes, or with any indication of such association. *Plate 46, figure 8* (Berry, *l. c.*) evidently hints at the internal structure but in too vague a manner for discussion.

Coniferous Stem. (PLATE 5, FIGURE 5.)

This is an interesting and unique specimen recalling the genus *Lepidodendron* of the Paleozoic. It represents a portion of a stem at the juncture of a branch, the leaf-scars of which were much hollowed out by decay before fossilization.

Prof. Lester F. Ward, to whom the specimen was submitted, suggested its possible relation to *Cunninghamites*, because of the latter's abundance in the Matawan formation.

* Newb. Fl. Amboy Clays, 132. *pl. 46. f. 9–13.* 1896.

It may be compared with our *plate 5, fig. 2*, which represents a branching stem similar in size and outline; the latter is silicified and retains remains of the attached leaves, rendering it reasonably certain that it is a portion of a stem of *Cunninghamites*.

Although comparisons are impossible because of the destruction of the type specimen, Dr. Hollick suggests that his *Strobilites inquirendus* from this formation may represent a distorted section of a stem like the one here figured.

PASSAIC, N. J.

Explanation of plates

PLATE 1

FIGS. 1, 2. *Andromeda Parlatorii* Heer.
FIG. 3. *Sassafras progenitor* Newb.
FIG. 4. *Tricalycites papyraceus* Newb.
FIG. 5. *Protophyllocladus subintegrifolius* (Lesq.) Berry.
FIG. 6. *Sassafras acutilobum* Lesq.
FIG. 7. *Magnolia tenuifolia* Lesq.
FIGS. 8, 9. *Ficus atavina* Heer.
FIG. 10. *Laurus proteaefolia* Lesq.
FIG. 11. *Dammara Cliffwoodensis* Hollick.
FIG. 12. *Pinus delicatulus* sp. nov.

PLATE 2. (Reduced one tenth)

Cones of *Sequoia gracillima* (Lesq.) Newb.

PLATE 3

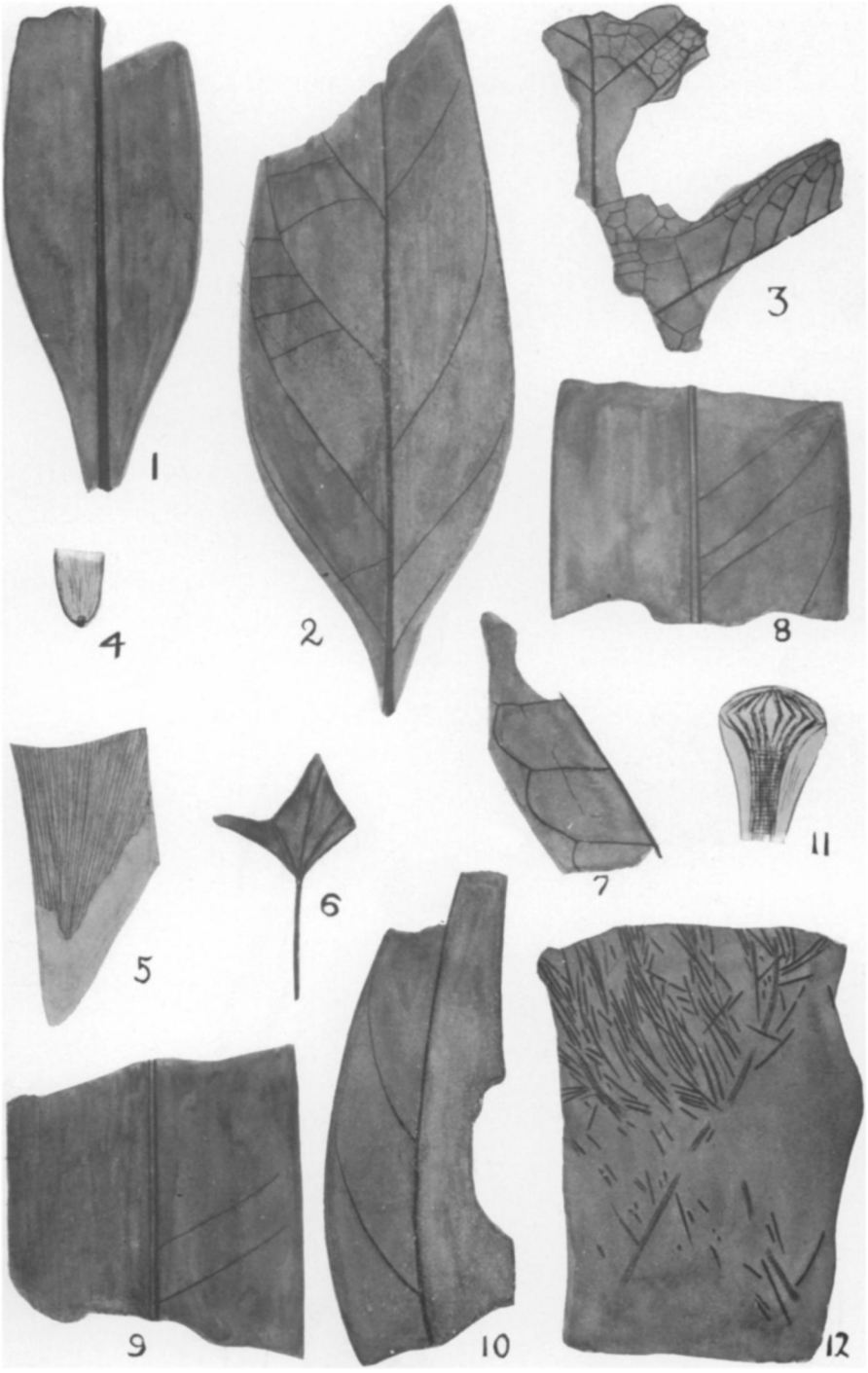
FIG. 1. *Laurus plutonia* Heer.
FIG. 2. *Laurus Hollickii* Berry.
FIG. 3. *Magnolia Capellinii* Heer.
FIGS. 4, 5. *Quercus Hollickii* Berry.
FIG. 6. *Ficus atavina* Heer.
FIGS. 7–9, 11. *Cunninghamites elegans* (Corda) Endl.
FIG. 10. *Magnolia speciosa* Heer.

PLATE 4

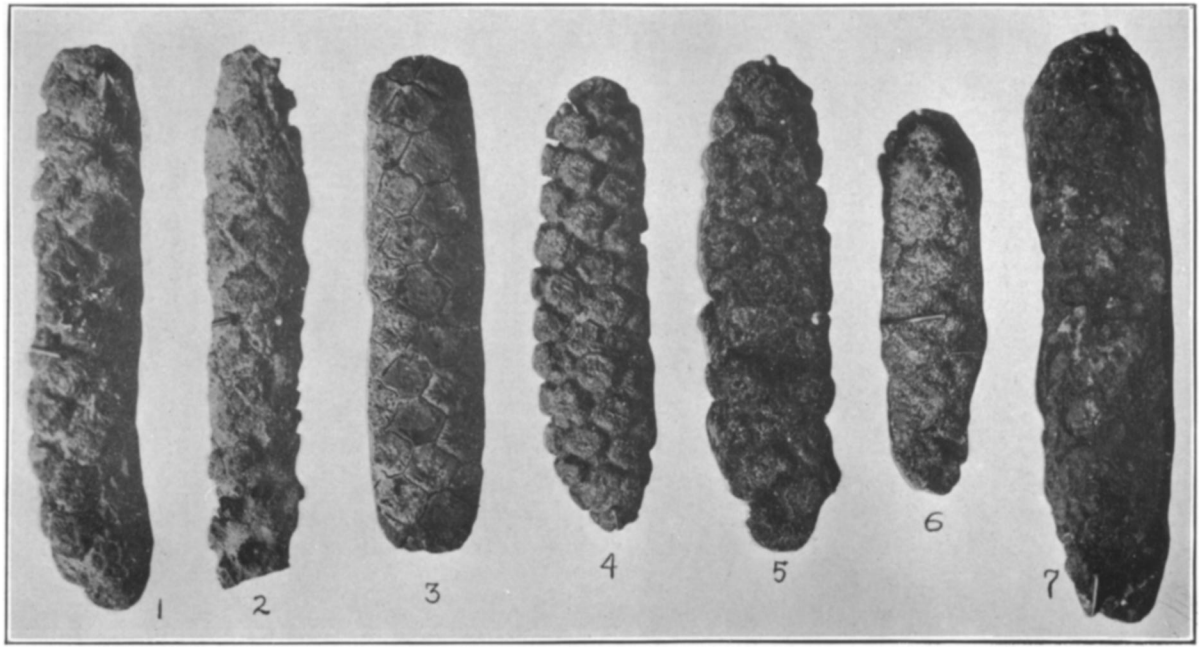
FIG 1. *Myrica Cliffwoodensis* sp. nov.
FIGS. 2, 3. *Geinitzia formosa* Heer.
FIG. 4. *Liriodendropsis angustifolia* Newb.
FIG. 5. *Eucalyptus Geinitzi* Heer.
FIG. 6. *Gleichenia Zippei* (Corda) Heer.
FIG. 7. Gymnospermous cone.
FIG. 8. *Sequoia Reichenbachi* (Gein.) Heer.
FIGS. 9, 10. *Frenelopsis Hoheneggeri* (Ett.) Schenk.
FIG. 11. *Quercus eoprinoides* sp. nov.
FIG. 12. *Aralia palmata* Newb.
FIG. 13. *Viburnum Mattewanense* sp. nov.

PLATE 5. (Reduced one tenth)

FIGS. 1, 5. Coniferous stems.
FIGS. 2, 3. Stems of *Cunninghamites*.
FIG. 4. Unknown organism.

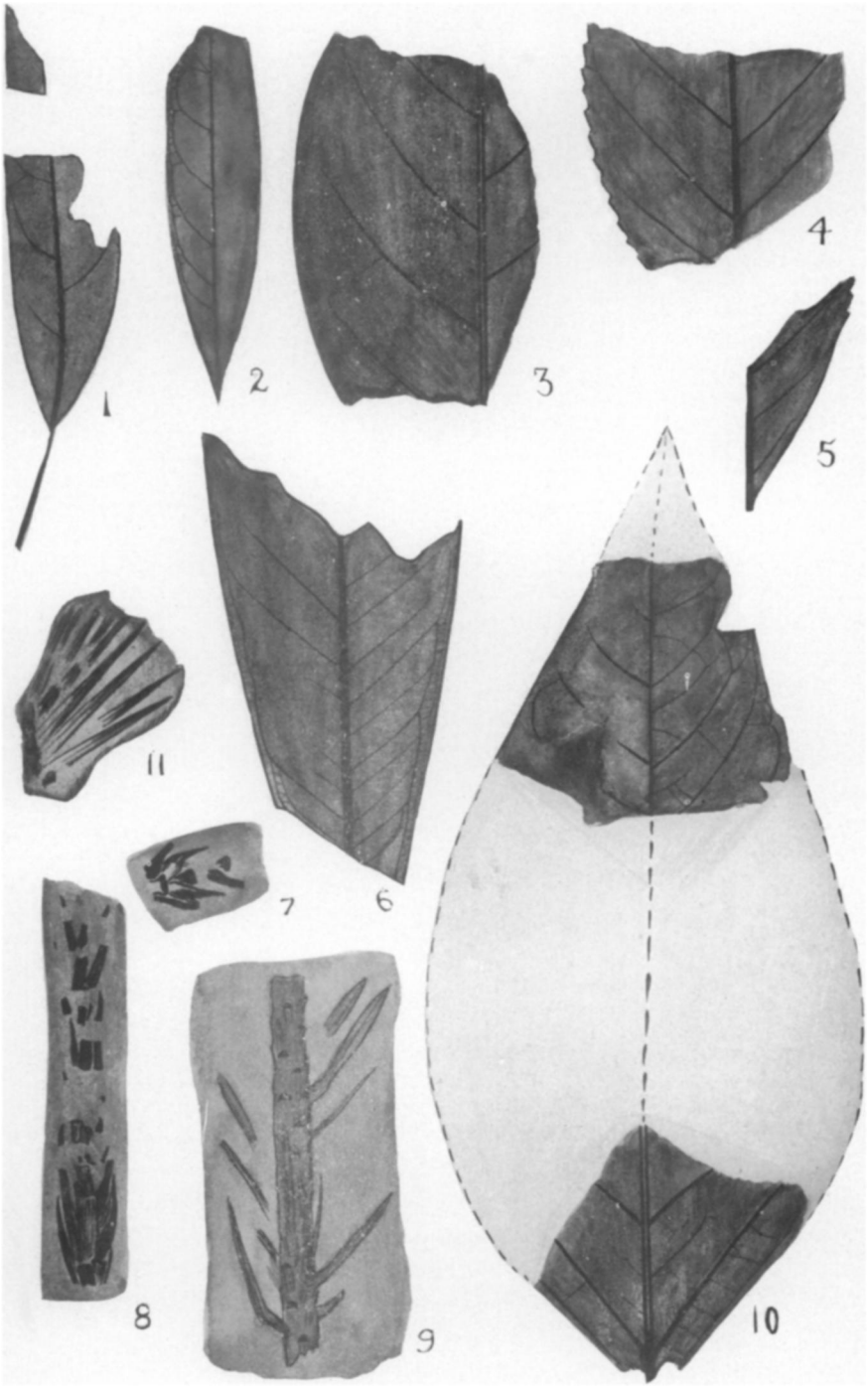


FLORA OF THE MATAWAN FORMATION



FLORA OF THE MATAWAN FORMATION

SEQUOIA GRACILLIMA (LESQ.) NEWB.



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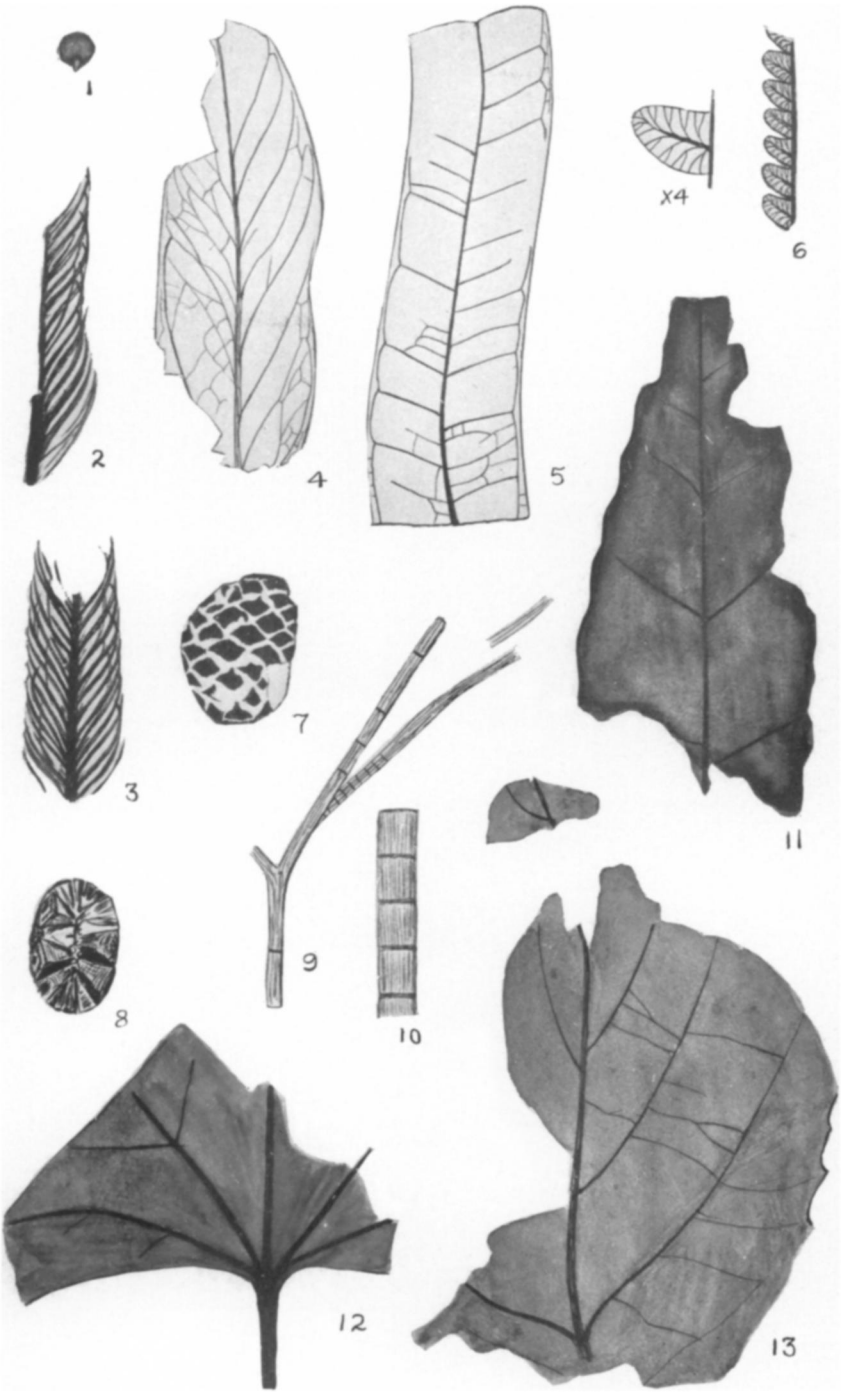

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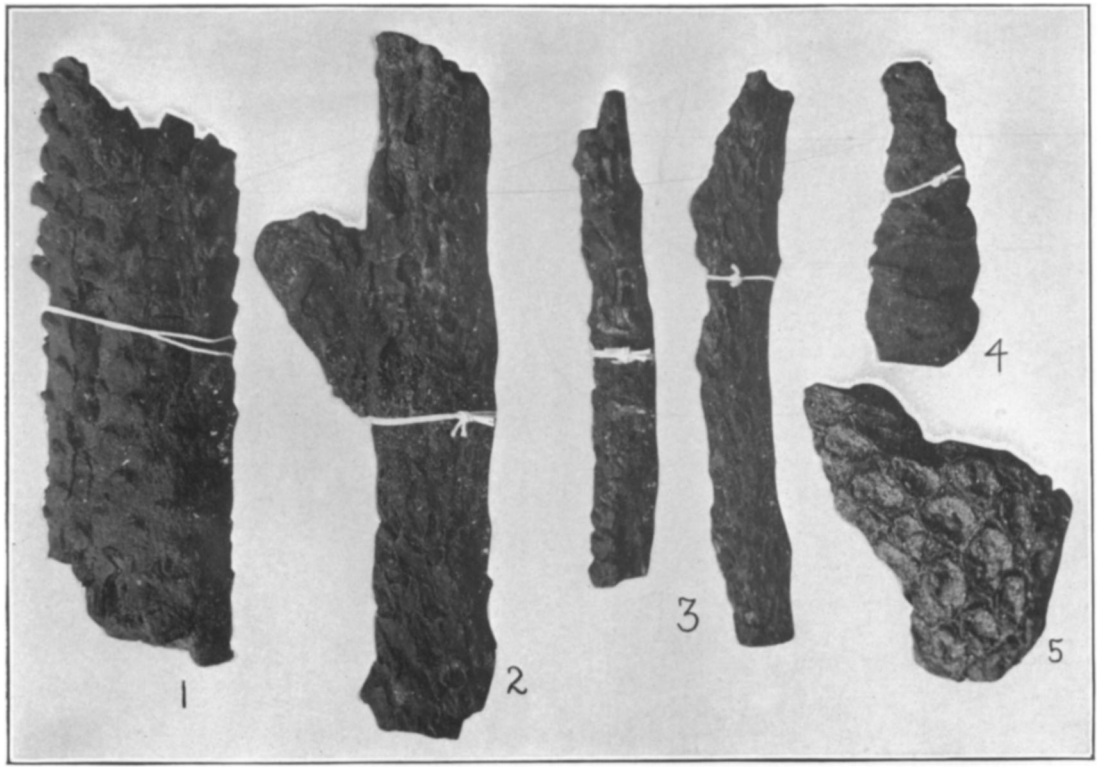

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